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Source apportionment of winter carbonaceous matter in Central Europe – three methods comparison

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Outline

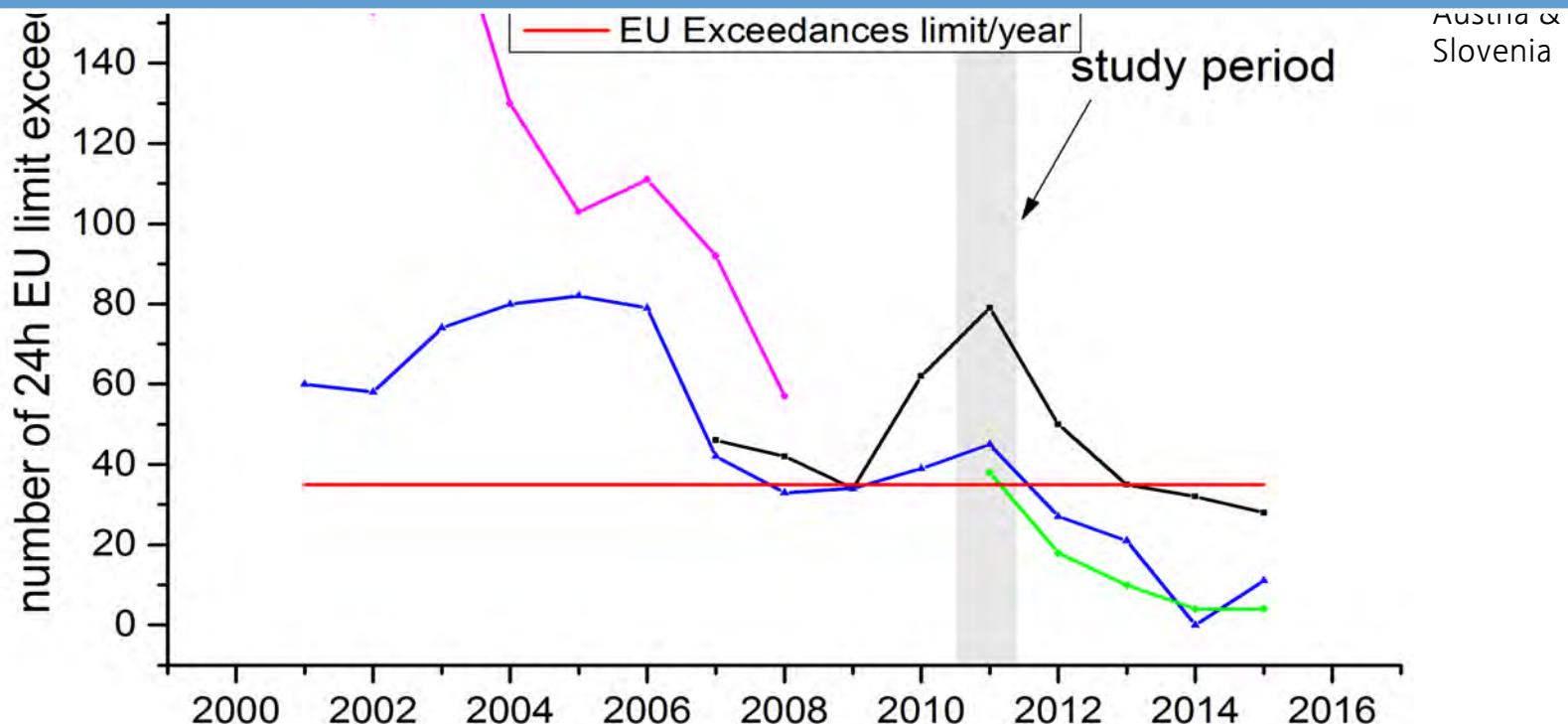
- Motivation
- General information on the PMInter project
- PM10 - sampling and analyses
- Comparison of three methods for SA of carbonaceous matter
 - Macro-tracer approach
 - Radiocarbon (^{14}C) measurement
 - Aethalometer model
- Conclusions

MOTIVATION

Frequent exceedances of PM10 limits in winter occurring at both urban and background sites of Austrian-Slovenian border region

MAIN GOAL

Identification of the sources responsible for the wintertime exceedances of EU-24h PM10 limit ($50\mu\text{g}/\text{m}^3$)



PMinter Project area



ICCPA, Berkely 13.08.2015



Measurements

- Continuous BC measurements over the whole project period
- Discontinuous PM10 sampling in campaigns
- Determination of PM10 composition on filters:
 - Carbon parameters (OC/EC, ^{14}C)
 - Inorganic ions
 - Saccharides
 - Al, Fe, H_2O

CONTINUOUS BC MEASUREMENTS (AETHALOMETER)

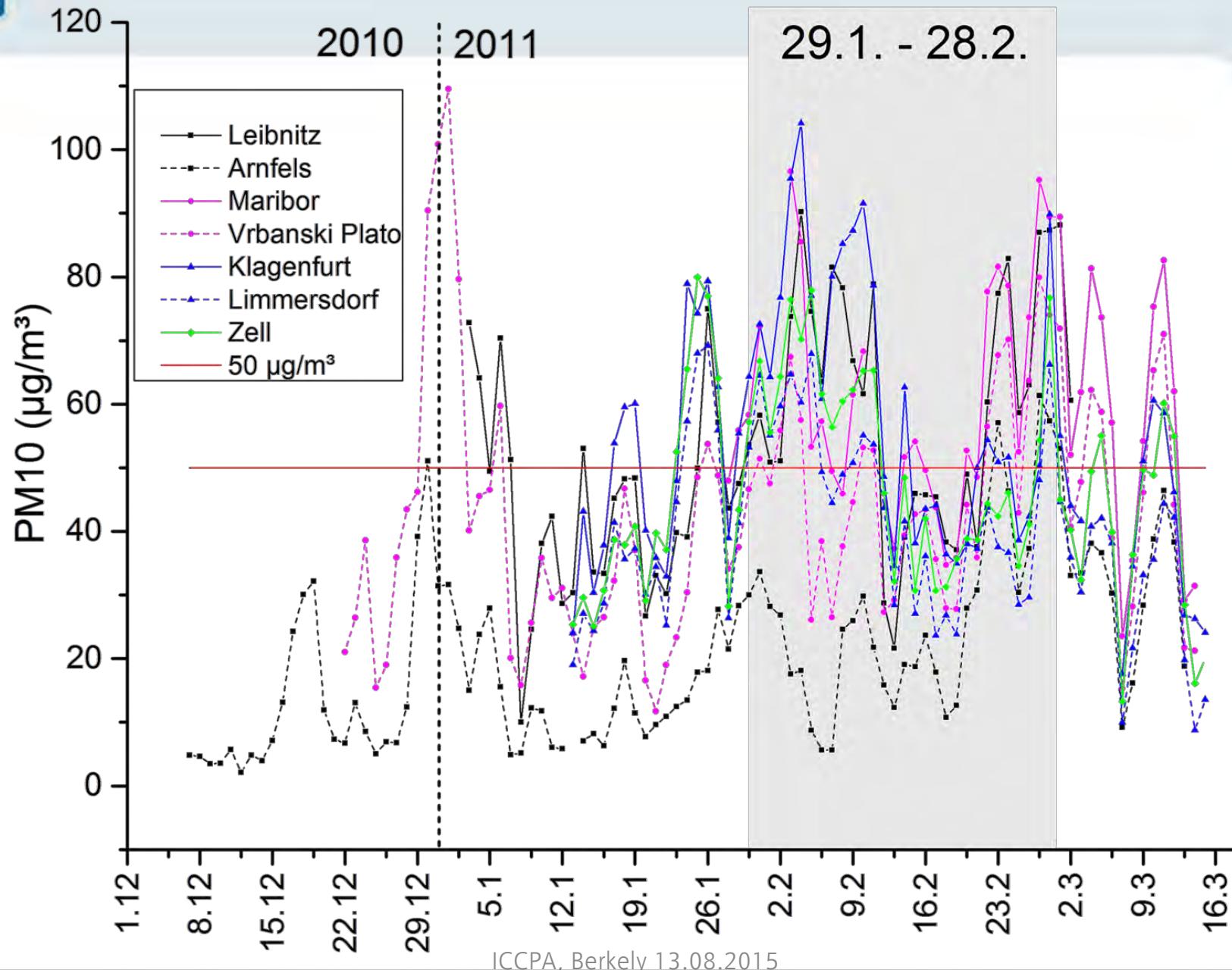
- Measurement of light attenuation @ different wavelengths
- High time resolution (seconds till minutes)
- Allow to differentiate between
 - fossil fuel burning,
 - wood combustion



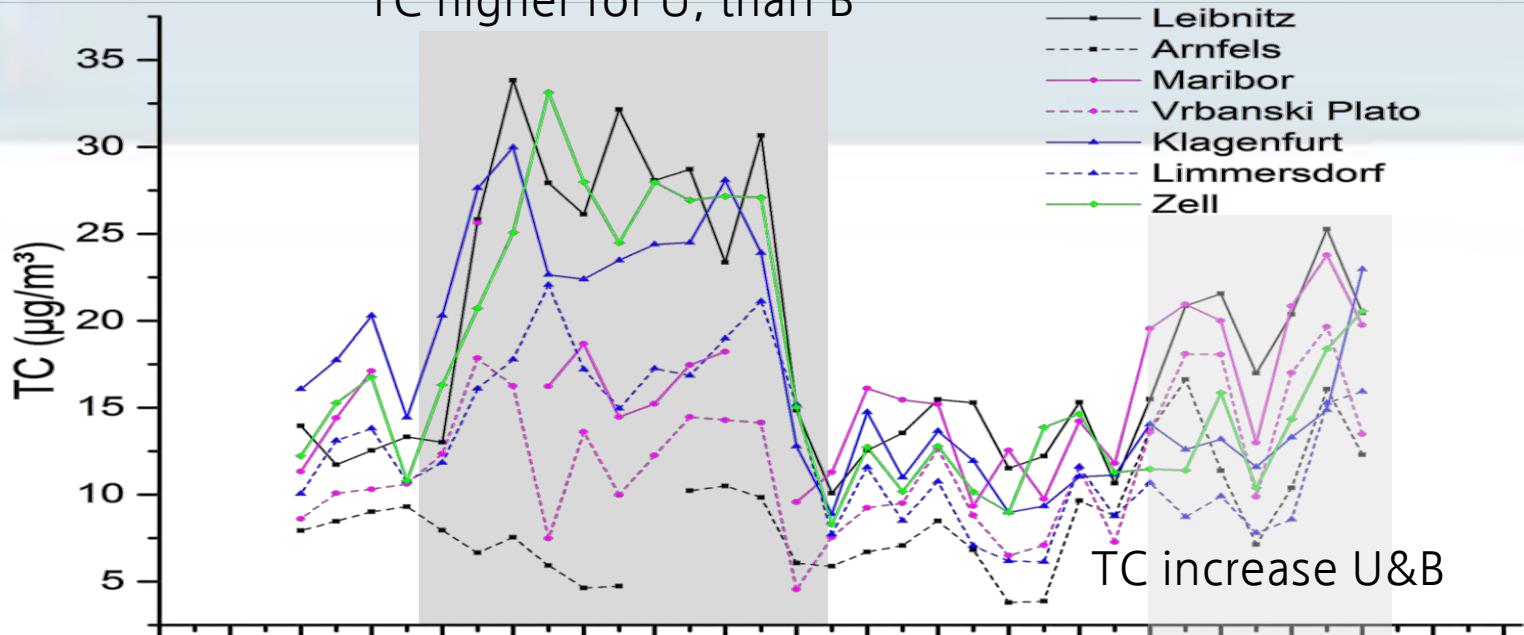
DISCONTINUOUS PM10 COLLECTION

- Hi-Vol samplers ($\sim 30 \text{ m}^3/\text{min}$)
- 24 h-operation cycle
- Automated filter change
- QF Filters, $\varnothing 150 \text{ mm}$
- Gravimetric mass determination (EN 12341)

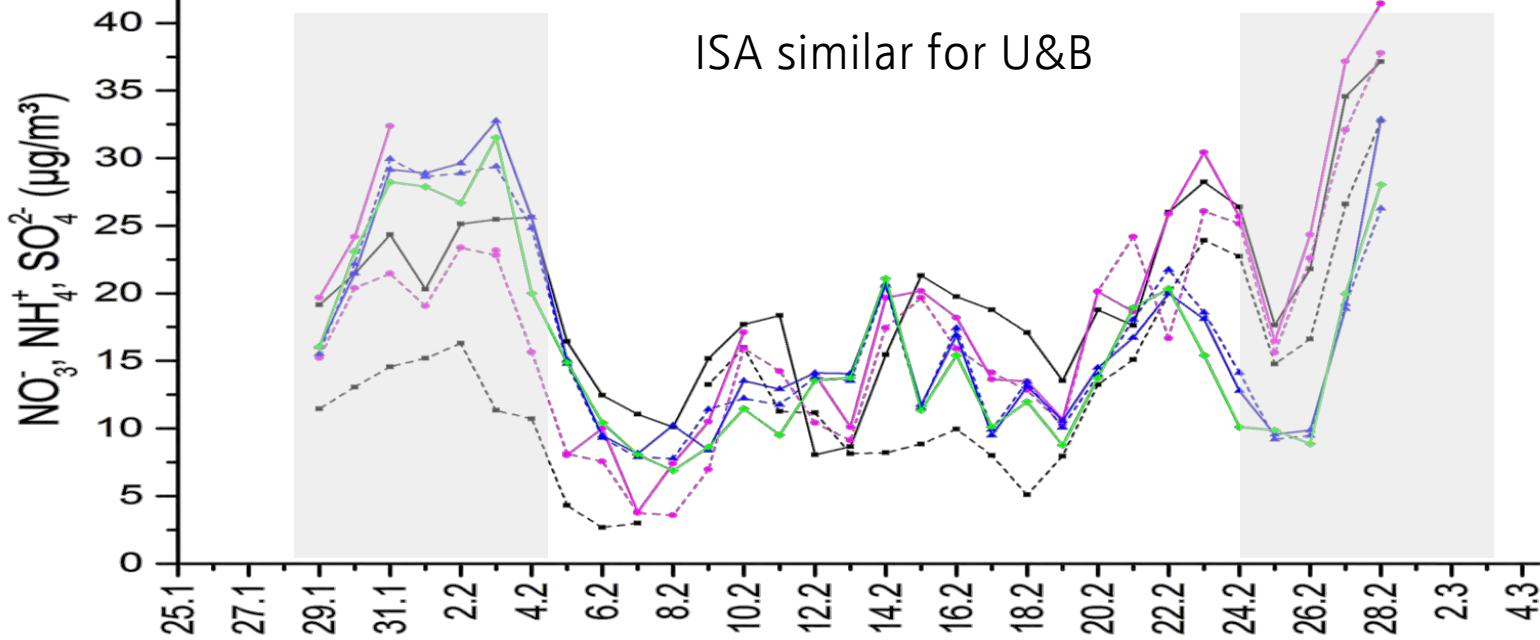




TC higher for U, than B

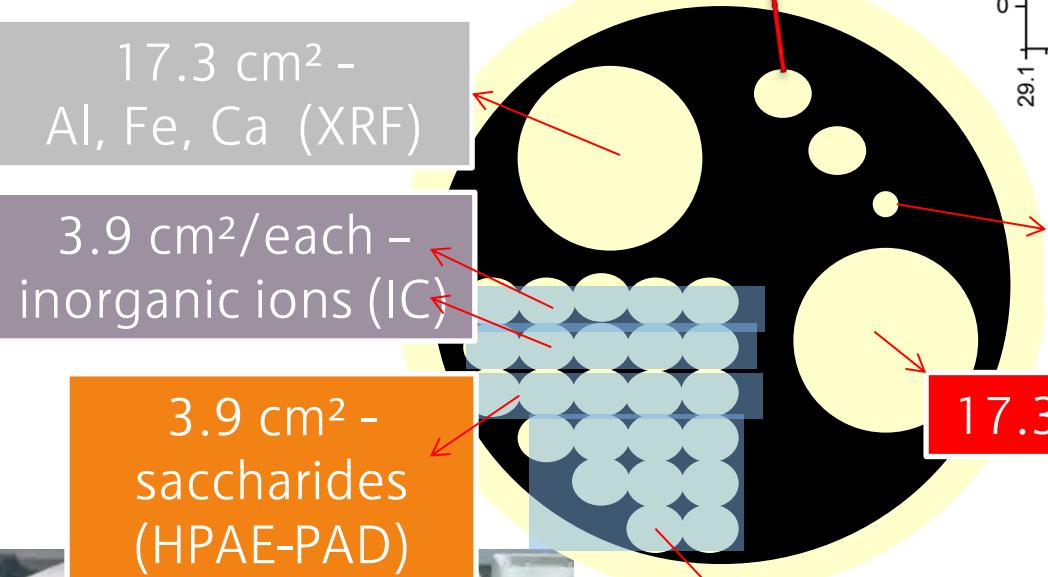
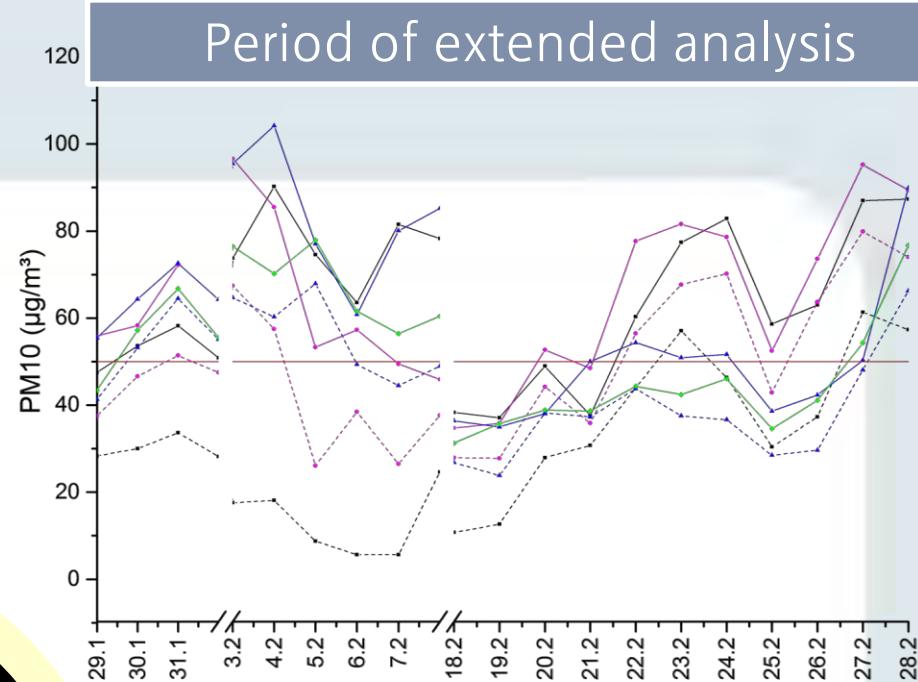


TC increase U&B





0.8 cm² - OC/EC (TO-T,
EUSAAR 2, Sunset, Inc.)



ICCPA, Berkely 13.08.2015



Source apportionment methods

	Carbonaceous matter	Non-carbonaceous aerosol
Macro-tracer	Traffic Wood burning HULIS Carbonates	SIA + aerosol H_2O De-icing salt
Radiocarbon	Fossil Non-fossil	
Aethalometer	Fossil Wood burning	

Macro-tracer sources

TRAFFIC

- Scaling factors from tunnel study conducted in Vienna
- OM/OC = 1.1
- „Traffic“ assumed as only fossil source
- „Traffic“ and „Wood burning“ assumed as only EC sources

WOOD BURNING

- Scaling factors from test-stand measurements
- fuel/stove use characteristic to the region
- based on Levoglucosan, Mannosan, EC, OC, PM
- OM/OC=1.5

$$\text{TrEx} = (\text{EC} - \text{EC}_{\text{WB}}) \times 1.33$$

$$\text{EC}_{\text{TrEx}} = \text{EC} - \text{EC}_{\text{WB}}$$

$$\text{OC}_{\text{TrEx}} = \text{EC}_{\text{TrEx}} \times 0.33 / 1.1$$

$$\text{WB} = \text{Levo} \times 16.8$$

$$\text{EC}_{\text{WB}} = \text{WB} \times 0.1$$

$$\text{OC}_{\text{WB}} = \text{Levo} \times 8.9$$

Handler, et al., 2008

Schmidl et al., 2008

Schmidl et al., 2011

Kistler, 2012, data in preparation for submission

Source apportionment methods

Question

Traffic (EC+OC)

Macro-tracer

=

SIA + aerosol
 H_2O
Diluting salt

Silicates
Traffic-
abrasion

Fossil (EC+OC)

Radiocarbon

=

Fossil (BC+OC)

??

Aethalometer

Source apportionment methods

Question

Macro-tracer

Wood burning (EC+OC)

=

Radiocarbon

Non-fossil (EC+OC)

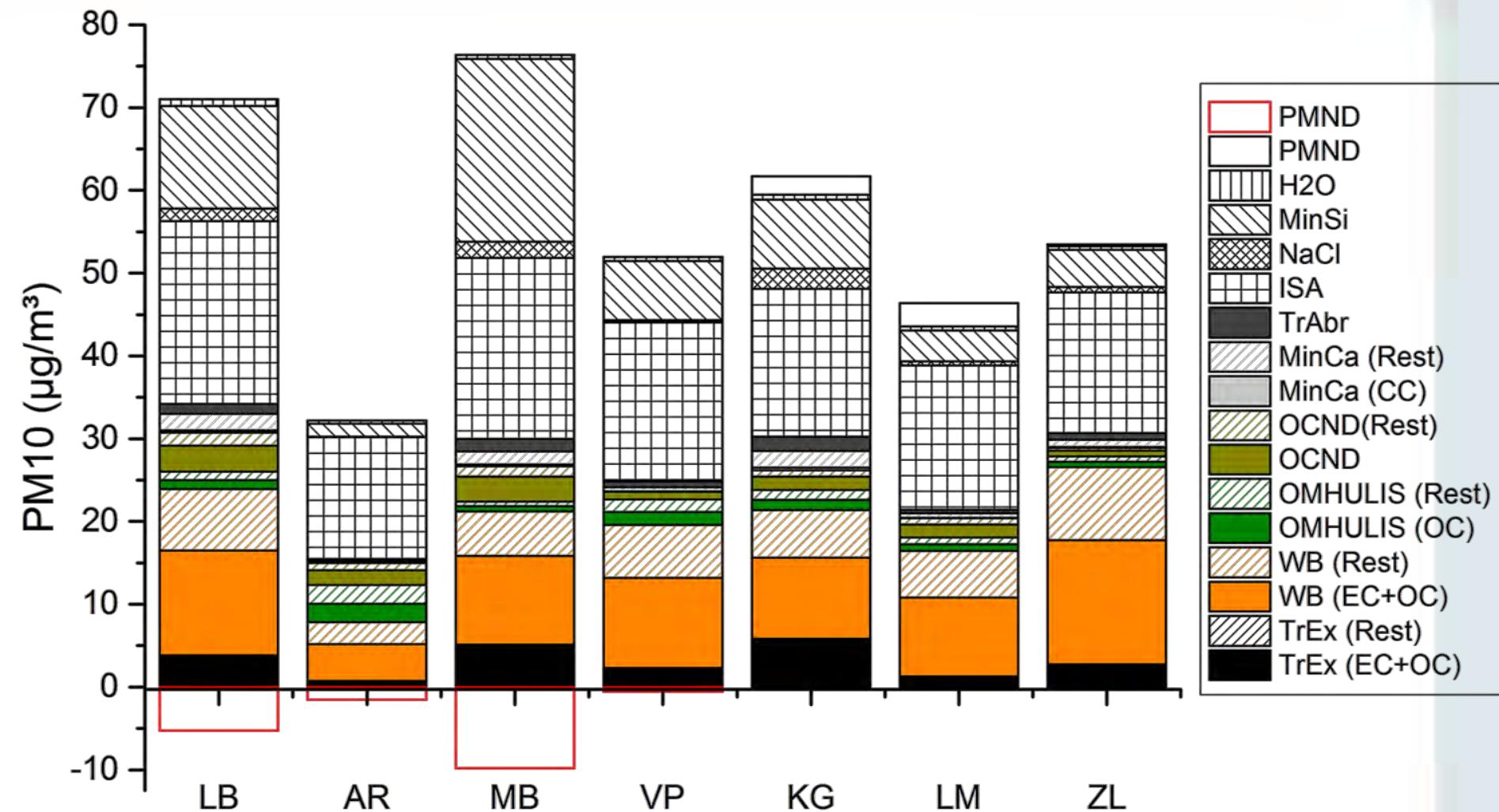
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Aethalometer

Wood burning (BC+OC)

? ?

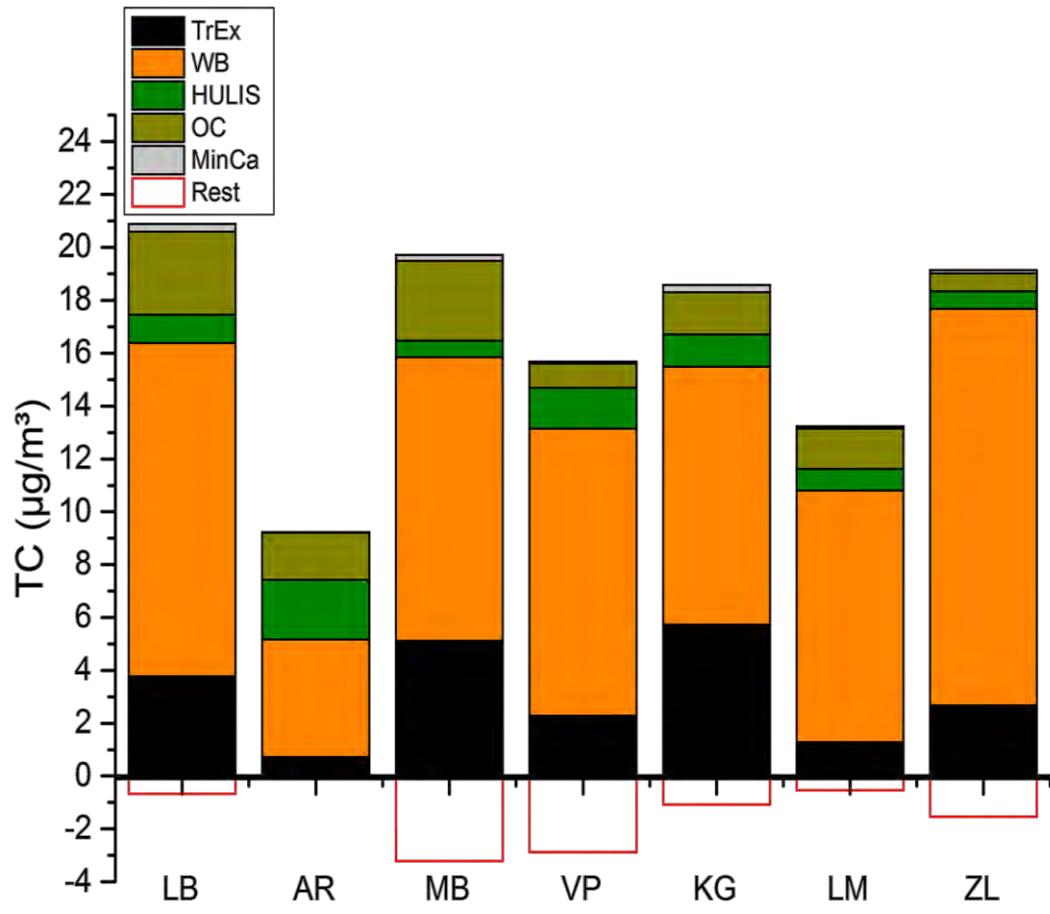
Macro-tracer model result



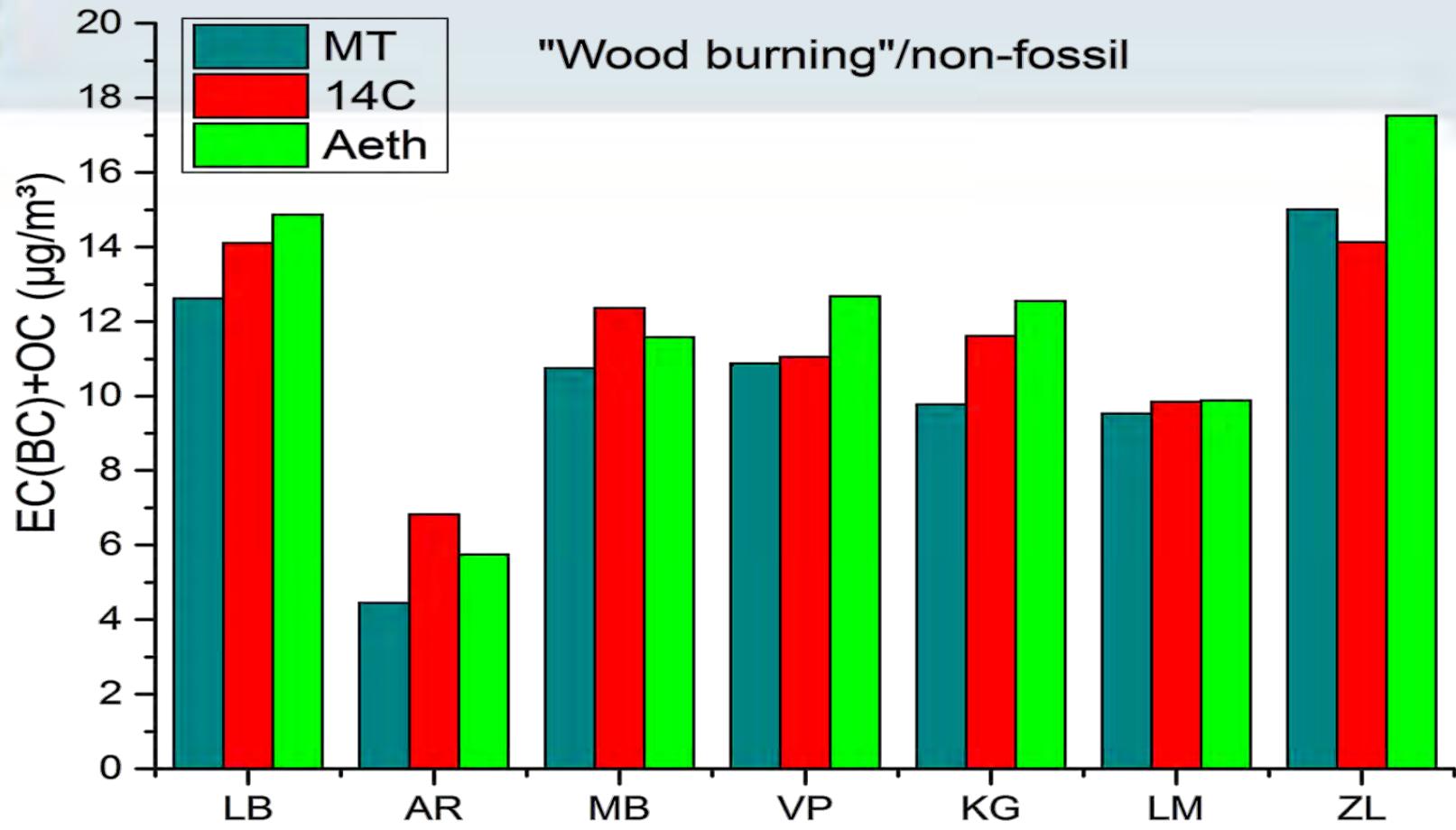
Source as % PM10

	TrEx	WB	HULIS-OM	OC-ND	MinCa	TrAbr	ISA	NaCl	MinSi	H2O	Sum
LB	5,9	30,5	3,2	7,2	3,5	1,8	33,6	2,3	18,8	1,2	108
AR	2,4	23,0	14,7	8,7	0,8	0,7	47,9	0,2	5,2	1,2	105
MB	7,7	24,3	1,8	6,4	2,7	2,2	33,0	3,0	33,2	0,7	115
VP	4,6	34,0	6,0	1,8	1,1	1,4	37,8	0,6	14,1	0,9	102
KG	9,5	25,1	4,0	3,9	3,7	2,8	28,9	3,9	13,5	1,0	96
LM	2,8	32,6	3,6	4,9	1,4	0,8	37,6	1,1	8,0	1,1	94
ZL	5,1	44,6	2,5	1,9	1,8	1,5	31,8	1,2	8,4	0,8	100

Macro-tracer model – TC SA

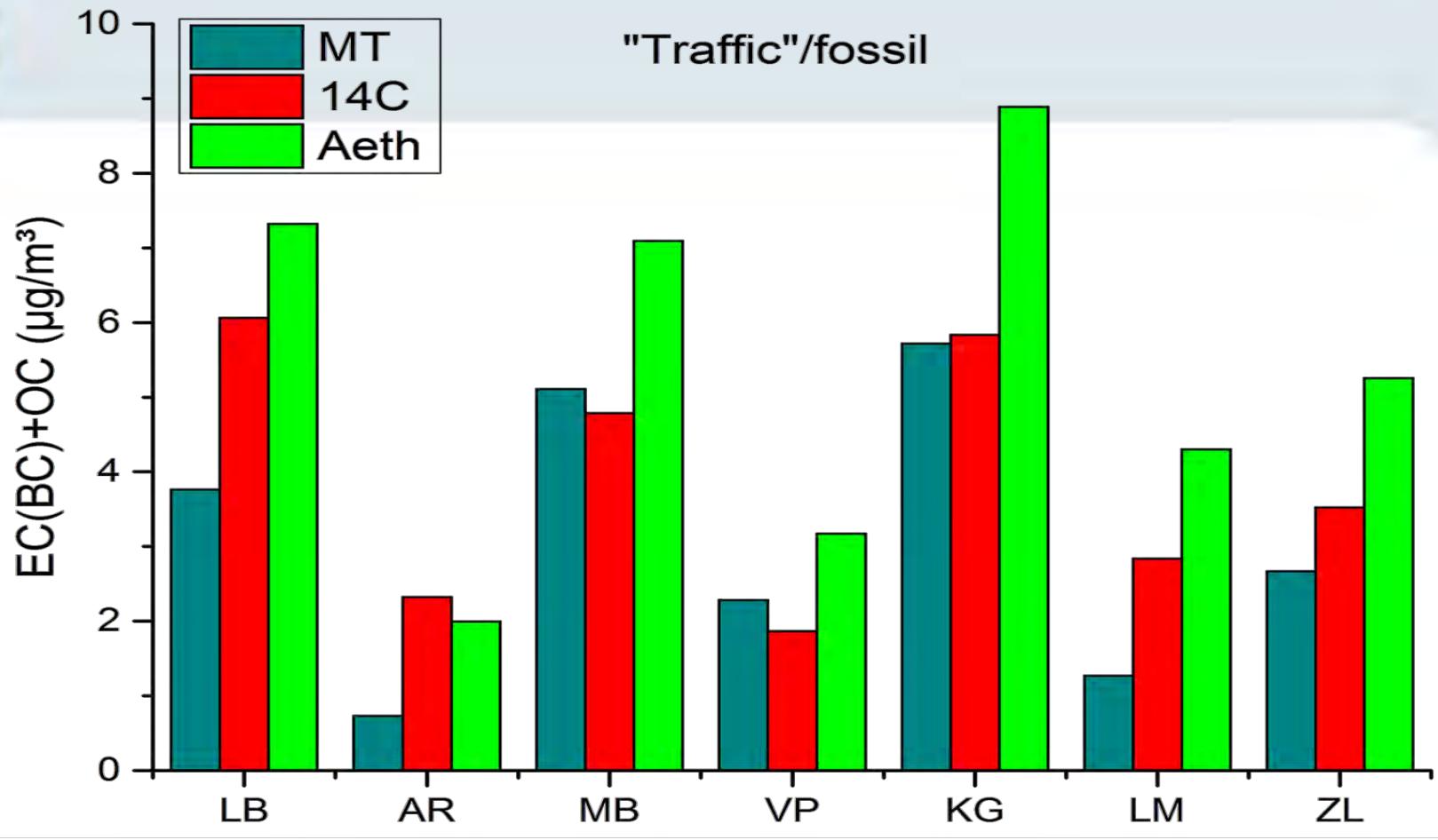


	Source as % TC					
	TrEx	WB	OC-HULIS	OC-ND	MinCa	Sum
LB	18,6	62,5	5,3	15,6	1,4	103
AR	7,8	48,4	24,5	19,4	0,3	100
MB	31,0	65,1	3,8	18,3	1,4	119
VP	17,8	85,0	12,0	7,2	0,5	122
KG	32,7	55,8	7,0	9,0	1,6	106
LM	10,0	75,0	6,5	12,0	0,6	104
ZL	15,2	85,3	3,8	3,8	0,7	109



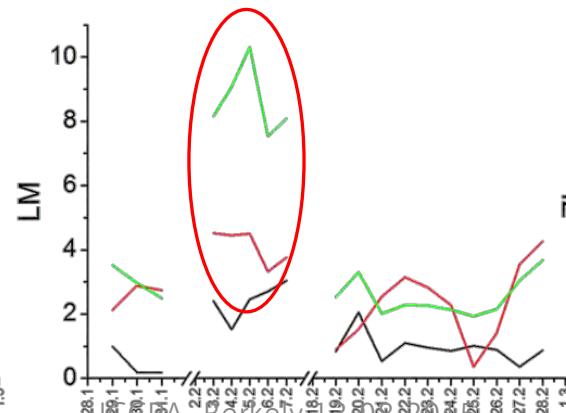
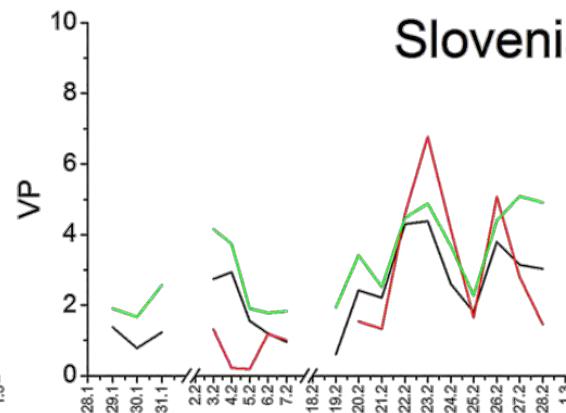
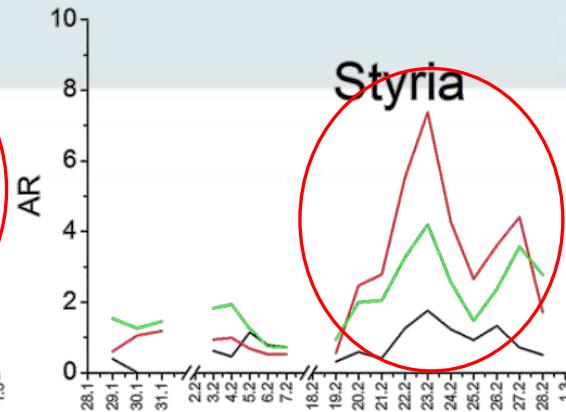
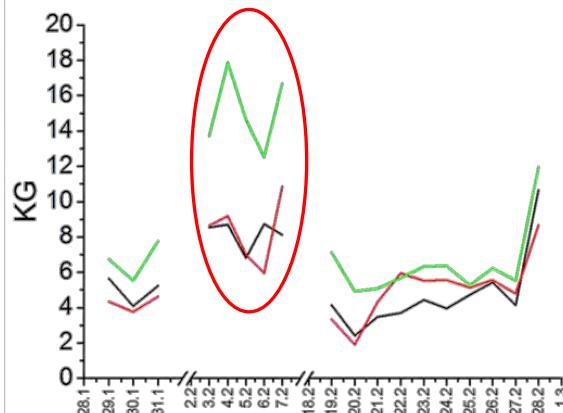
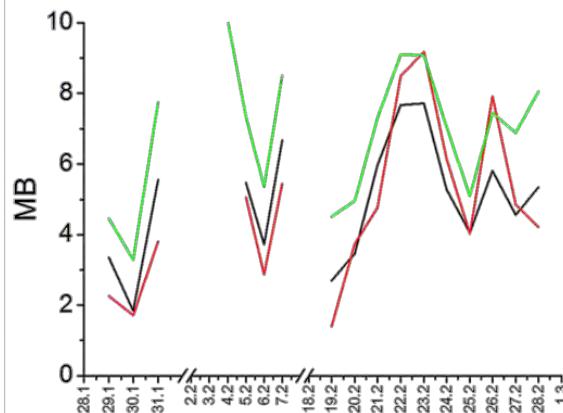
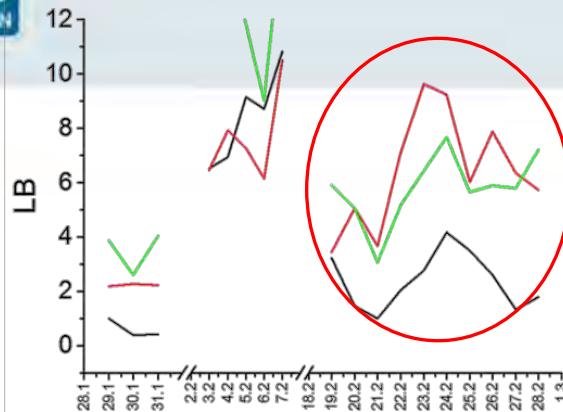
Comparison of modeled TC fraction in relation to ^{14}C measurement

		LB	AR	MB	VP	KG	LM	ZL
MT	AVE	0,89	0,65	0,87	0,98	0,84	0,97	1,06
	STDEV	0,13	0,10	0,18	0,22	0,16	0,18	0,15
Aeth	AVE	1,05	0,84	0,94	1,15	1,08	1,00	1,24
	STDEV	0,16	0,16	0,16	0,25	0,54	0,16	0,59



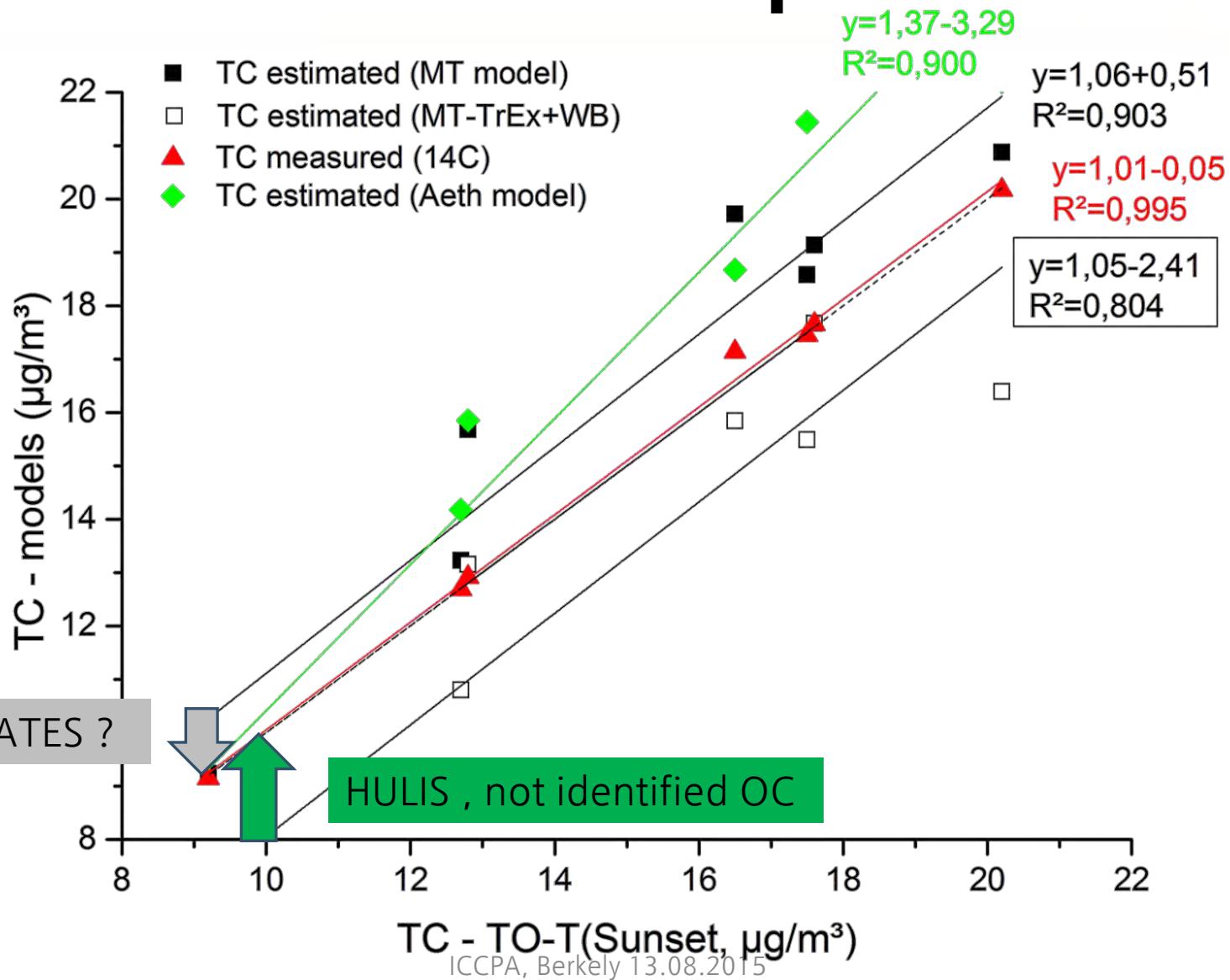
Comparison of modeled TC fraction in relation to ^{14}C measurement

		LB	AR	MB	VP	KG	LM	ZL
MT	AVE	0,62	0,31	1,07	1,22	0,98	0,45	0,76
	STDEV	0,40	0,50	0,30	3,92	0,23	0,64	0,37
Aeth	AVE	1,21	0,86	1,48	1,70	1,52	1,51	1,49
	STDEV	0,44	0,60	0,56	5,73	0,46	1,12	0,85



Are those differences due to other sources?

To sum up



PM10 Sources

- Macro-tracer model → 4 carbonaceous PM10 sources identified (43-56% PM10 mass), 9 in total (94-115%)
- Residential wood combustion highest OC+EC contribution constant in the whole region
- Traffic (fossile fuel burning) → urban sites (max. 10%)
- HULIS (WS-SOA) → background sites (max. 14%)

SA Methods

- WB vs non-fossil → good agreement all sites and methods
- Traffic vs fossil → filter measurements lower than optical method, higher variations (>50%)
- Variations in temporal trend of “Traffic/fossil” → other sources?



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Thank you for your attention!

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